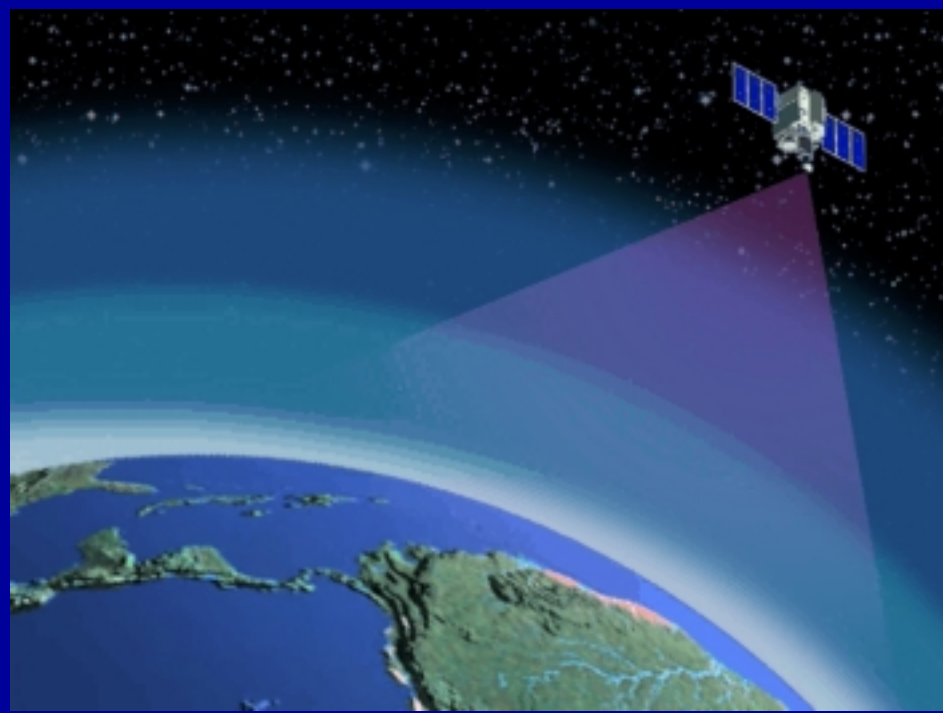




Aviation: Improving Observations

**180 Balloon Stations
observe twice daily**

**GIFTS: 1km x 4km
100,000 obs/minute**



**High-resolution observations are required to accurately
locate hazardous weather for aviation**





Aviation Safety

Weather Forecasting for Cockpit Visualization

\$2B/year

Partners:



EOS, NPP, NPOESS & GOES-R

GIFTS – Geosynchronous Fourier Transform Spectrometer Turbulence & Weather Prediction Modeling

Aqua and NPP fly the AIRS and CrIS sensors (Atmospheric Infrared Sounder and Cross-track Infrared Sounder)

NAST (I) Atmospheric Sounder Testbed Infrared (Proteus) Experiments

Advanced Satellite Applications Products (ASAP) Program

State 1-WX Visualization Systems: Discrete, Stand-alone weather products, with little satellite sounding data or imagery

State 1-WX Sensors/Data Sources: Ground Doppler Radar, 2x daily balloon readings yield 6 to 12-hour forecasts; poor oceanic coverage

State 2-WX Visualization Systems: Fully integrated SVS, WARP & ITWS in-cockpit graphical WX displays featuring real-time weather information with global coverage

State 2- WX Sensors/Data Sources: AIRS, CrIS & GIFTS fully integrated into NEXRAD & TDWR systems; prepared for seamless integration of ABS (GOES-R)

NAS-wide Data Link WX Products provide severe weather location and movement data to controllers and aircrews to promote common situational awareness

Geostationary satellite technology improvements will vastly improve remote measurement of altitude-resolved vector winds and temperatures, allowing for efficient flight planning, operations and traffic management.

High spectral (vertical), horizontal and temporal resolution satellite measurements will render precise numerical weather forecasts and extremely high-resolution wind fields based on the tracking of atmospheric water vapor

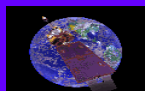
Airborne validation of NPOESS instruments provides DSS product development teams with experience at integrating hyperspectral data and information in preparation for subsequent GIFTS and GOES-R missions

Integration of existing GOES imagery and sounding data into AWRP products improve Terminal Convective WX product and Integrated Turbulence Forecast

Current trajectory:

Steady improvement in fielding and integration of hyperspectral LEO and GEO satellite data into NWS aviation weather products and AWRP visualization systems, resulting in fully integrated, real-time global aviation WX coverage

Enhanced Aviation Weather DSS and synthetic vision systems that reduce the aviation fatal accident rate by a factor of 10 by 2022



GOES-L, M

2000



Proteus

2002



Aqua

2004



NPP/VIIRS

2006

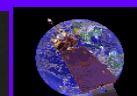


GIFTS

2008



*NPOESS



GOES-R

2010

*Pre-formulation

2012

Socioeconomic Impact

Disaster Management: Predictions

Thunderstorms and Hail



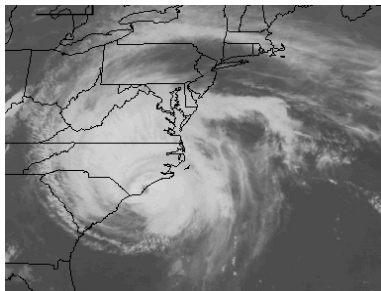
Extratropical Cyclones



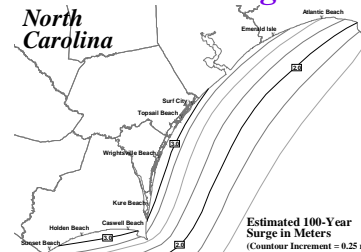
Tornadoes



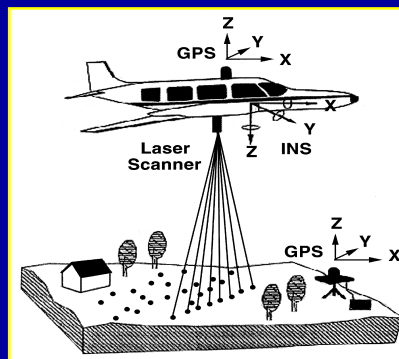
Hurricanes



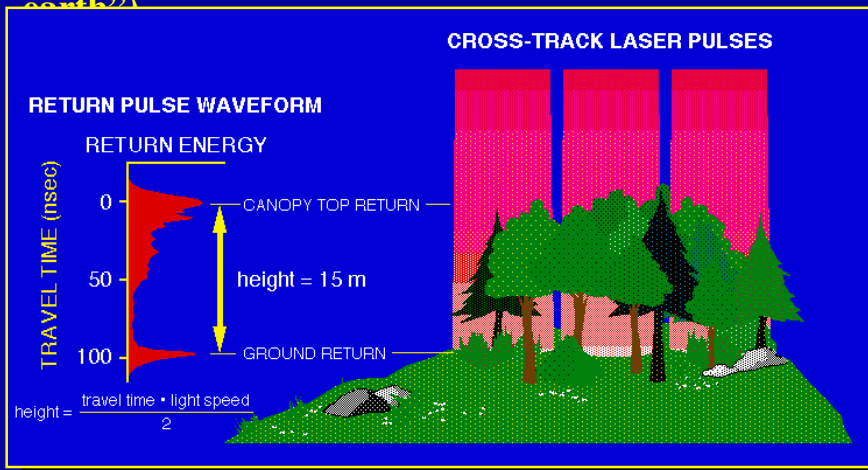
Storm Surge



Light Detection and Ranging (LIDAR)



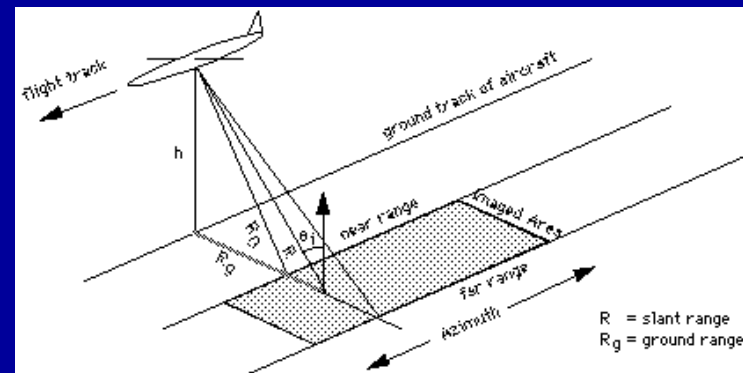
- Potential for high accuracy (10-20 cm range)
- Potential for below- canopy measurements (“bald-
pate”)



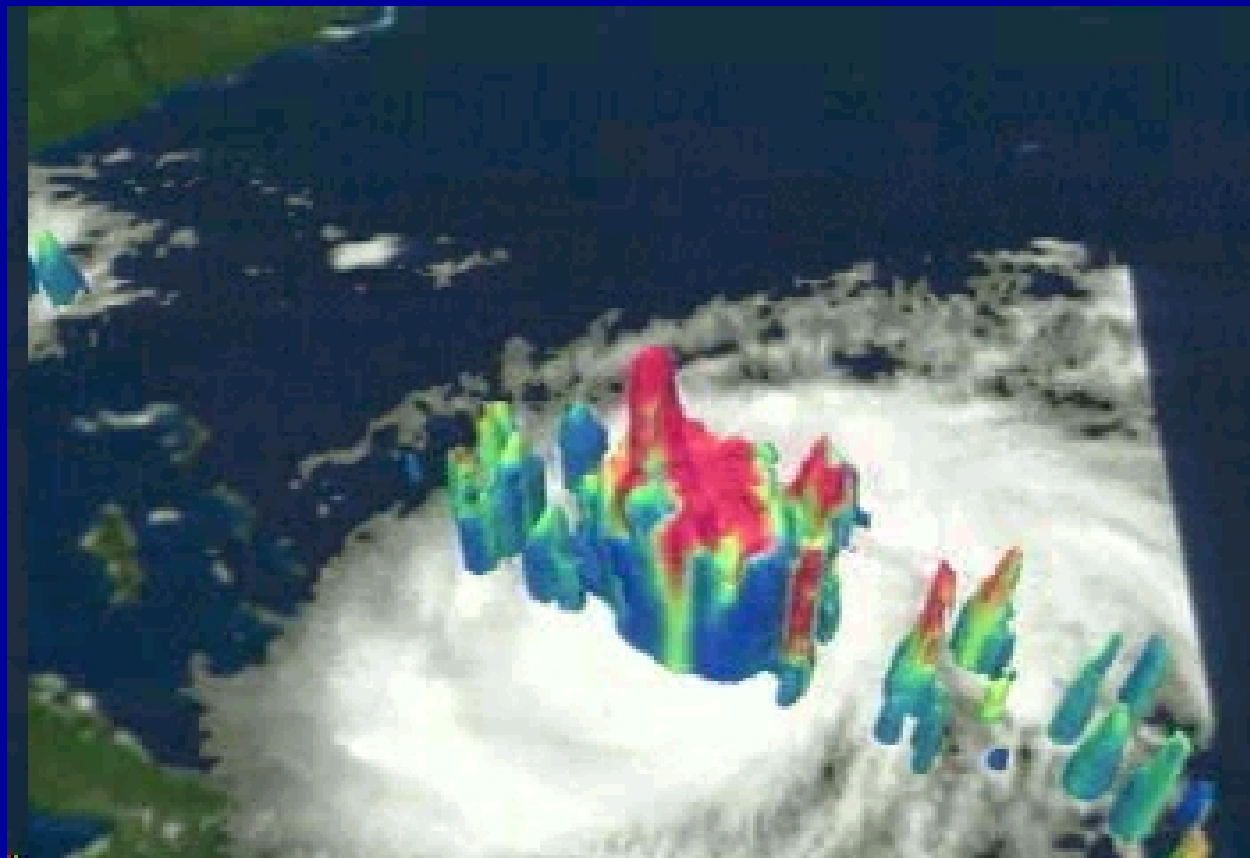
Interferometric Synthetic Aperture Radar (IFSAR)



- Accuracy levels between 1.5 and 3m over broad flat areas (may ultimately be 0.5 m or lower), but varies over terrain
- Cover larger areas than LIDAR



- Using QuikScat data, forecasters can now predict hazardous weather events over the oceans as much as 12 hours earlier.
- Researchers are developing methods that can detect potential tropical cyclones more than 40 hours earlier than with traditional methods.
- TRMM is providing 3 dimensional maps of precipitation structure.





Disaster Management: **HAZUS - Risk Assessment and Loss Estimation**

Date: 6/14/2002



HAZUS:
Earthquakes
Hurricanes
Flooding
Tornadoes

Primary Partners:



Transfer of advanced event-modeling capabilities using next-generation hardware, software, and communications

Outcomes:
Improvement of FEMA capabilities across all hazards and phases

Impacts:
Reduce losses across all disasters

Provision of real-time weather products for FEMA response applications

Outcomes:
Improvement of FEMA response capabilities

Impacts:
Reduce losses across all weather-driven disasters

Provision of EOS standard products with minimal time delay for FEMA response applications

Outcomes:
Improvement of the HAZUS High Winds Module Final Version

Impacts:
Reduce losses related to hurricane and high wind disasters.

Landsat-7 data for characterization of Forest species type, canopy structure, biomass, and tree height, width, and crown

Outcomes:
Improvement of the HAZUS High Winds Module

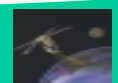
Impacts:
Reduce losses related to hurricane and high wind disasters.

FEMA-37 Floodplain Mapping Standard

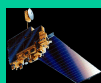
Outcomes:
Improvement of all US Floodplain Maps feeding the HAZUS Flood Module

Impacts:
Reduce losses related to flood disasters.

HAZUS:
Earthquakes



SeaWiFS



Terra



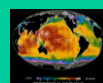
Jason-1



Aqua



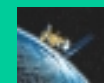
SeaWinds



OcnTopo



* OSWinds



NPOESS

* Pre-formulation

An operational decision support system for quantification and verification of solutions for natural hazard predictions.

Socioeconomic Impact

2000

2002

2004

2006

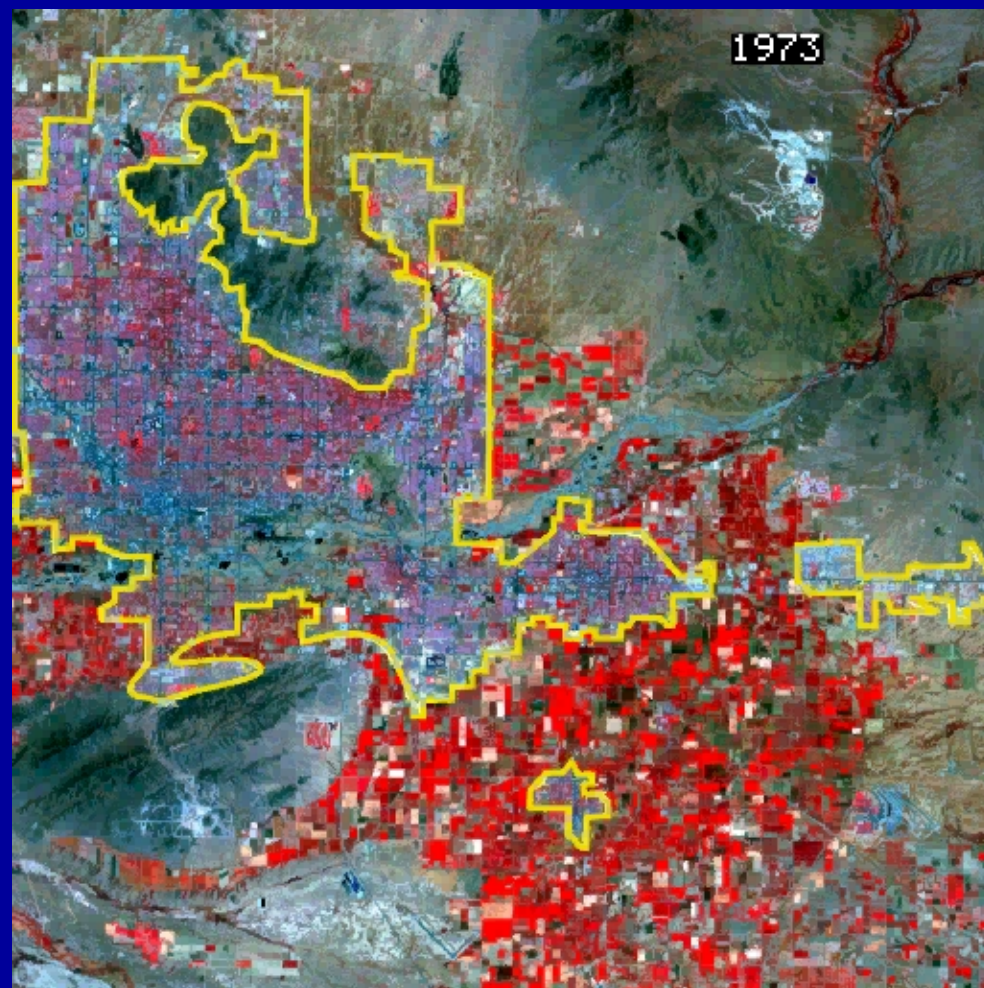
2008

2010

2020

Community Growth: Urban Dynamics

- Transportation Infrastructure
- Urban Growth Planning
- Conservation & Preservation
- Human Impacts on the Land
- Infrastructure and Utilities



Phoenix, AZ





URBAN HEAT ISLAND: Assessment, forecasting and mitigation

Improved Community Sustainability



Create stronger links to public health:

- Respiratory health alerts
- Real time air quality forecasting

Outcomes:

More timely public information on air quality-related health dangers



Improve biogenic emissions models:

- Utilize higher-resolution landcover data
- Improve treatment of surface properties (albedo, moisture)

Outcomes:

Improved biogenic emissions, particularly in urban areas with complex surfaces



Improve spatial resolution of models:

- Atmospheric models
- Emissions and photochemical models

Outcomes:

More accurate and more highly-resolved temperature and air quality forecasts



Implement anthropogenic urban heating in mesoscale atmospheric models:

- Transportation sources
- Building sources

Outcomes:

More accurate simulation of urban air temperatures and consequently air quality

Increase stakeholder input into developing solutions for UHI and air quality problems:

- Develop and refine UHI mitigation strategies
- Conduct urban 'fabric analysis'

Outcomes:

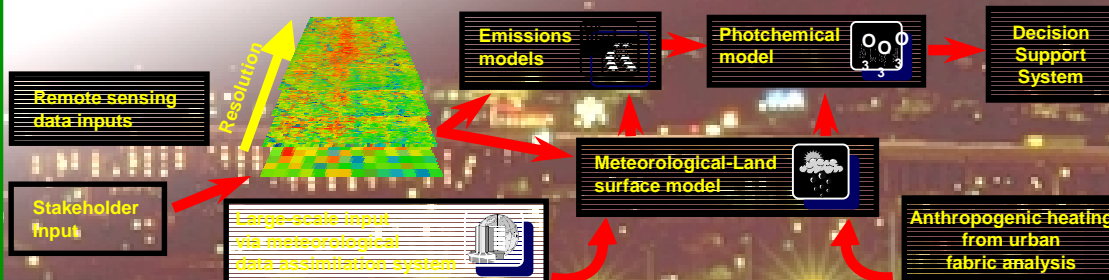
More realistic assumptions about potential mitigation strategies, better understanding of the role of urban composition in the UHI effect

Improve utilization of currently available data:

- Land surface characterization
- Surface albedo
- Surface temperature, emissivity

Outcomes:

Improved local atmospheric forecasts; improved estimates of emissions and ozone production



2002

2004

2006

2008

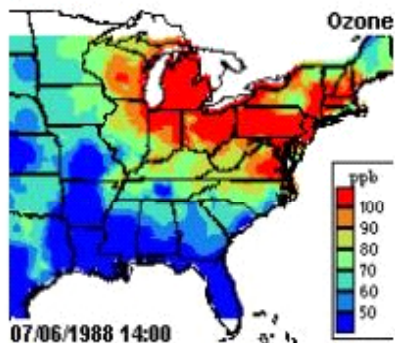
2010

2012

Operational Decision Support System for enhanced community development, habitability, and sustainability

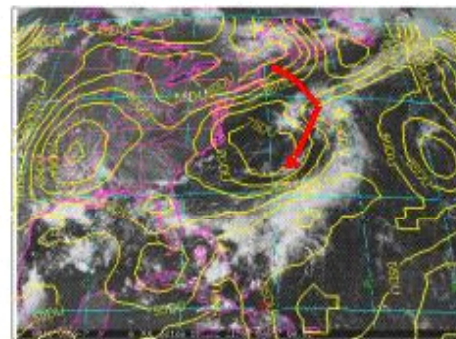
Satellite Data Captures Northern Pollution Invading Southern States

**July 6: Major Northern
Pollution Event Established**

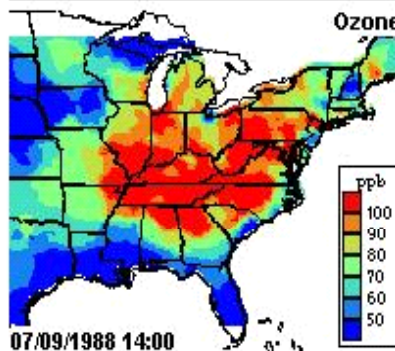


Backward trajectory
calculations show air
from North
contributing to ozone
pool

**Ozone Builds Off Coast
Behind Stationary Front**

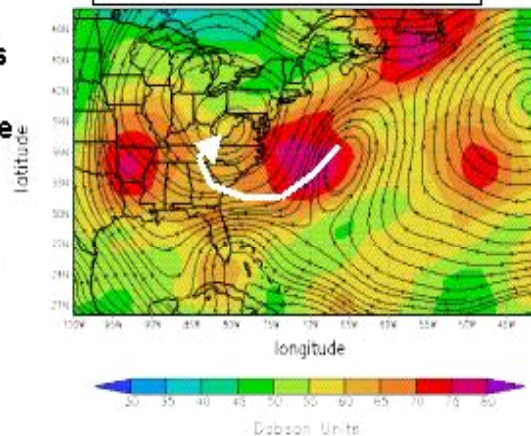


**July 9: Pollution Episode
Develops In South**



Forward trajectories
show eastward
transport from ozone
maximum off the
coast of North
Carolina into the
South 3 days later


**Meteorology Conducive to
Widespread Stagnation**



from Fishman and Balok [1999, *JGR*, 104, pp. 30,319]



Air Quality Management: Clean Air Standards and Air Quality Forecasts

Earth System Modeling Framework
Forecasts (c. 2012): 

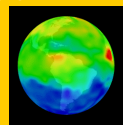
- Robust emissions control planning
- Routine warnings of pollution events
- 3-day air quality forecasts

Prevent 1,000s premature deaths/year
Mitigate \$5-10 B reduced crop yields

Primary Partners:



- Day/night chemistry/transport
- Trace gas measurements
- Boundary layer resolution

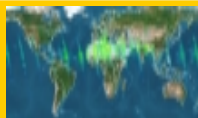


Outcomes: Improved pollution forecasts. Improved national emissions control planning/mitigation.

Impacts: Mitigate major illnesses and deaths from air pollution episodes.

AURA - TES

- Global/regional/local distribution of ozone
- Tropospheric mixing & B.L. interaction

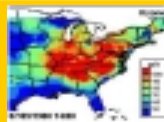


Outcomes: Source & destination of long-range dust & pollutants. Route airplanes. Issue health alerts and NAAQS waivers.

Impacts: Mitigate wear on airplanes and engines. Improve crop estimates for international markets.

AURA - OMI

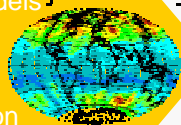
- Ozone profiles/transport
- Build on TOMS & GOME
- Aerosol & trace gas characteristics



Outcomes: Assess development policies to achieve or maintain compliance. Improve forecasts of PM and pollution episodes. Warnings to hospitals & farmers.

Impacts: Mitigate lung related diseases (asthma, bronchitis, pneumonia). Improve visibility. Benefit crop health & yields.

- Coupled chemistry-aerosol models
- Optical depth data
- Continental inflow/outflow
- Robust satellite data assimilation



Outcomes: Quantify contributions of physical & chemical processes to pollutant concentrations. Improve forecasts of ozone and regional transport.

Impacts: Accurate, timely forecasts & warnings reduce impaired lung function and use of medications. Reduce hospital admissions and lost work/school days.


- Validations
- Ozone residuals
- Better boundary conditions



Outcomes: Assess effects of emission control options. Evaluate development options and emission strategies to set policies and State Implementation Plans (SIP).

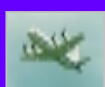
Impacts: Achievable SIPs permit air quality compliance which reduce development restrictions and improve economic development opportunities within States and Regions.

*Current trajectory:
Steady improvement in
chemistry-transport models and
pollution episode warnings.*

 **CMAQ Forecasts (c. 2002):**
State/regional planning.
Same-day air quality predictions.



TOMS



GTE



Aqua



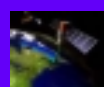
AERONET



Aura



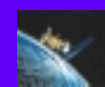
CloudSat



CALIPSO



* Total Column



*NPOESS

* Pre-formulation

2000

2002

2004

2006

2008

2010

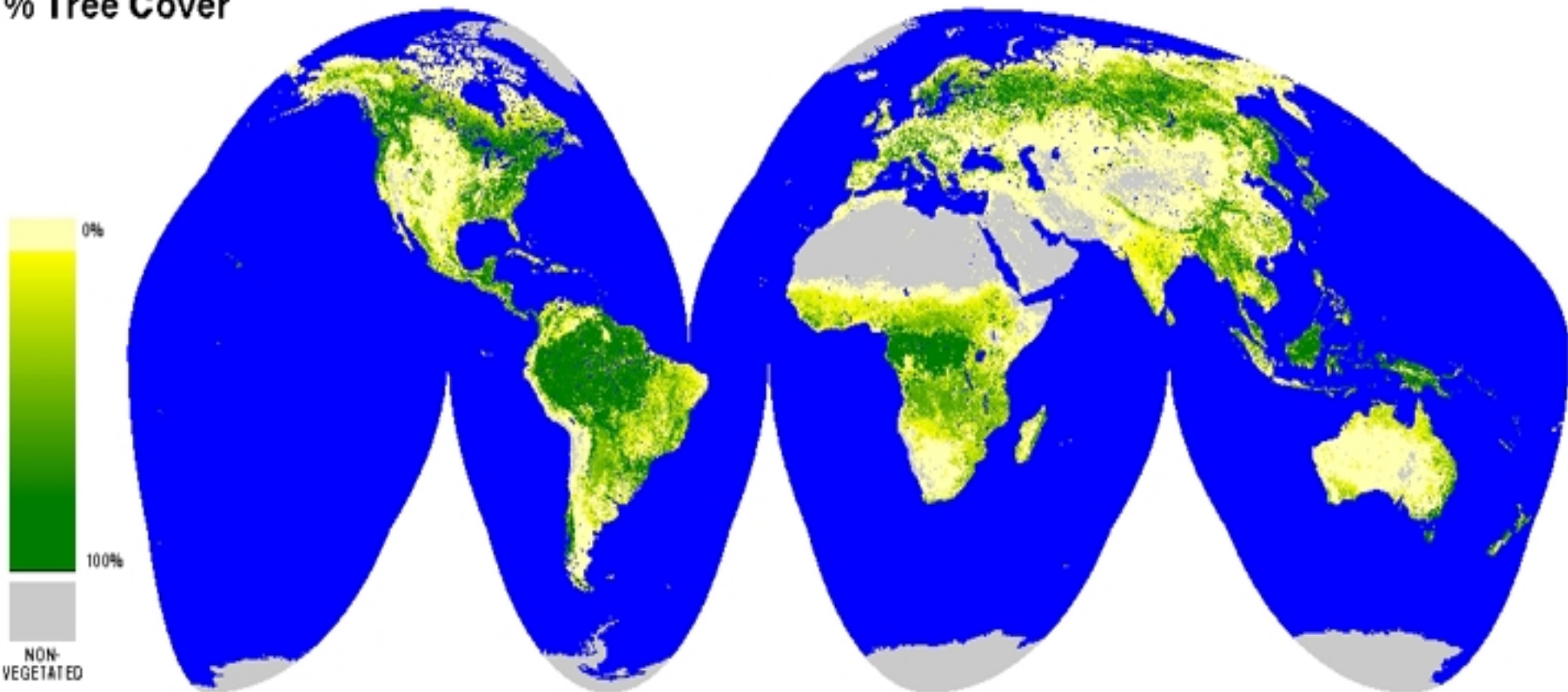
2012

Improved capabilities to air quality management tools to assess, plan and implement emissions control strategies & improve air quality forecasts.

Socioeconomic Impact

Carbon Management: Sequestration

% Tree Cover



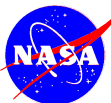
A prototype data set estimating percent tree cover from 10 to 80 percent based on satellite data acquired by the Advanced Very High Resolution Radiometer in 1992-93. Percent tree cover is likely to be underestimated in areas with significant cloud cover throughout the year. The spatial resolution of 1 km precludes the detection of finer forest fragments. Future satellites with higher spatial resolution will improve detection of forest patches as well as areas undergoing land cover change. Note that this is an equal area map projection and hence tree cover in high latitudes appears less extensive than in conventional maps.

Global Percentage Tree Cover Product derived from AVHRR data

John Townshend / Ruth Defries, University of Maryland

11





Carbon Management: *Toward a Carbon Management Regime*

Carbon Management DSS:
Land Sequestration Capacity
Ocean Sequestration Capacity

Date: 6/14/2002

Primary Partners:



Socioeconomic Impact

Global Atmospheric CO₂

Field-level assessment of carbon storage and atmospheric flux

Second-generation global land cover and change products

Capability to assess and predict sink duration (ie. credit longevity) for different land uses

Soil Surface Moisture Measurement*

Enables modeling of soil carbon storage as a function of soil fertility and vegetative processes

Forest height & canopy volume sampled globally. First global land cover change data product

Capability for volumetric assessment of above ground carbon sinks (3-D vs former 2-D capability) Potential to reduce frequency of costly *in situ* measurements

N. American Carbon Program and related international results incorporated into models (w/ C data assimilation).

Regional monitoring of carbon storage in biomass and soils
Regional assessment of candidates for carbon sequestration projects

Exploratory studies to extract atmospheric CO₂ from existing satellite sensors; coupled atmospheric-terrestrial model

Assessment of carbon sink strength at continental scale
Capability to discriminate between land and atmospheric carbon fluxes

EOS & global land cover observations; Carbon data model assimilation

Baseline information and dynamics of terrestrial carbon sources and sinks

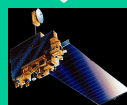
Current trajectory:
Steady improvement in model coupling, process characterization, assessment of carbon sources and sinks



Prototype Carbon DSS



Landsat 7



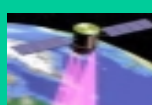
Terra



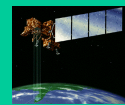
Aqua



NPP/VIIRS



**VCL



LDCM



NPOESS

*Pre-formulation
**In review

An operational decision support system for quantification and verification of terrestrial and oceanic carbon sequestration

2000

2002

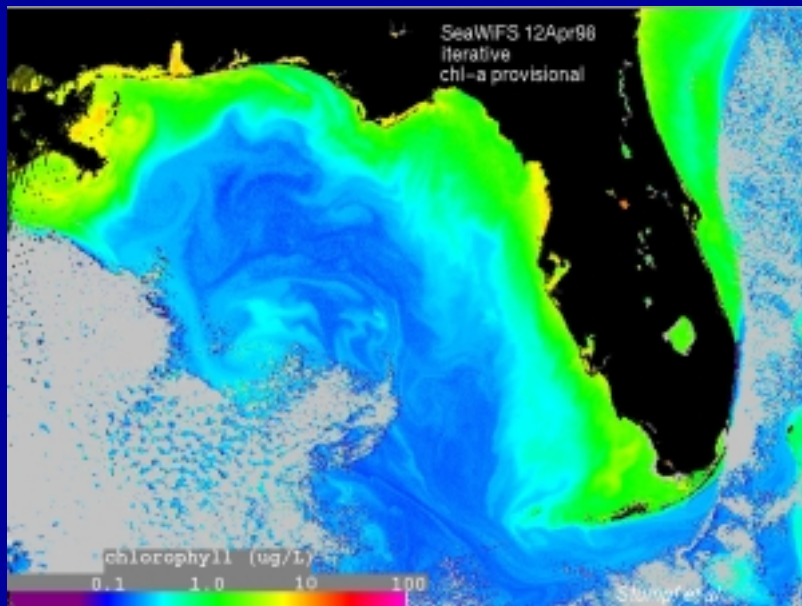
2004

2006

2008

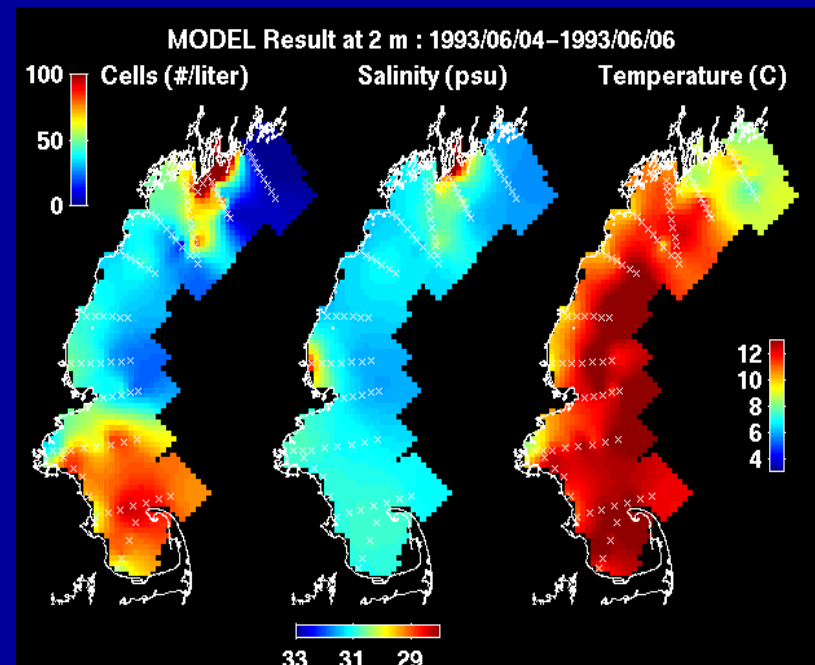
2010

2012



Current Capacity:

Respond to bloom detection with bio-physical models using satellite data and *in situ* sampling to forecast trajectories and impacts



Future Capacity:

Prediction of bloom onset





Coastal Management: Harmful Algal Blooms (HAB) & Hypoxia

Date: 6/14/2002

HAB/Hypoxia Forecasts (c. 2012)



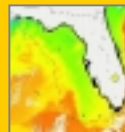
- X-Y day warning
- X% initiation
- Y% landfall +/- X km
- X% dissipation



Primary Partners:



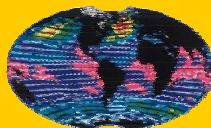
- Day/night S.S.Temp
- 3-D coastal circulation models incorporating biological data



Outcomes: 3-4 day warning of landfall. Routine detection. False negatives less than X%.

Impacts: Raise quotas for shellfish harvesting prior to HAB onset.

- Sea surface winds*
- HAB/phytoplankton speciation



Outcomes: Routine identification of particular HAB species. Improved estimates of toxin severity 2-3 day landfall warning.

Impacts: Improve design and location of aquaculture facilities.

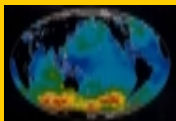
- Bio-optical sensors
- Improved coastal circulation models



Outcomes: Predictions of HAB transport, direction, and demise along coasts. Improved estimates of landfall area

Impacts: Warnings to fisheries and aquaculture facilities. Reduce impacts to non-target areas.

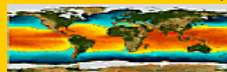
- Improved 2-D ocean circulation models
- Rain rates & salinity
- Sea surface height



Outcomes: 1-2 day warning of general landfall. Improved estimates of HAB demise. Warnings to close beaches.

Impacts: Reduce public exposure to toxins. Reduce hospital admissions and lost work/school days.

- Ocean color for chlorophyll a
- Sea surface temperatures

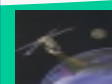
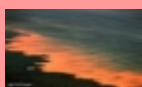


Outcomes: 0-1 day warning of landfall. Better understanding of HAB speciation. Improved estimates of initiation.

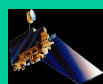
Impacts: Reduce economic impacts as possible. Build public confidence in forecasting systems.

Current trajectory: Steady improvement in circulation models, HAB transport, and warning times.

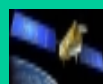
HAB/Hypoxia Forecasts (c. 2002)



SeaWiFS



Terra



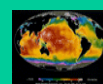
Jason-1



Aqua



SeaWinds



OcnTopo



* OSWinds



NPOESS

* Pre-formulation

2000

2002

2004

2006

2008

2010

2012

Improved capabilities to decision support systems to forecast HAB initiation, transport, toxic severity, landfall and demise.

Socioeconomic Impact

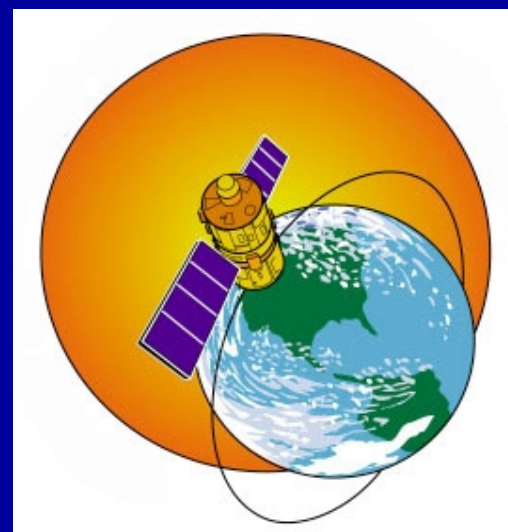
Surface Solar Energy Project

Objective

To synthesize and convert scientific data to renewable energy industry standards

History

- NASA Surface Radiation Budget Project develops surface solar insolation data set for solar cooking w/ DOE/NREL
- February 1998, "Development of Surface Solar Energy Data Sets for Commercial Applications for Placement of Solar Power Facilities" proposal funded by NASA
- Meteorological data added (surface temperature, moisture and winds)





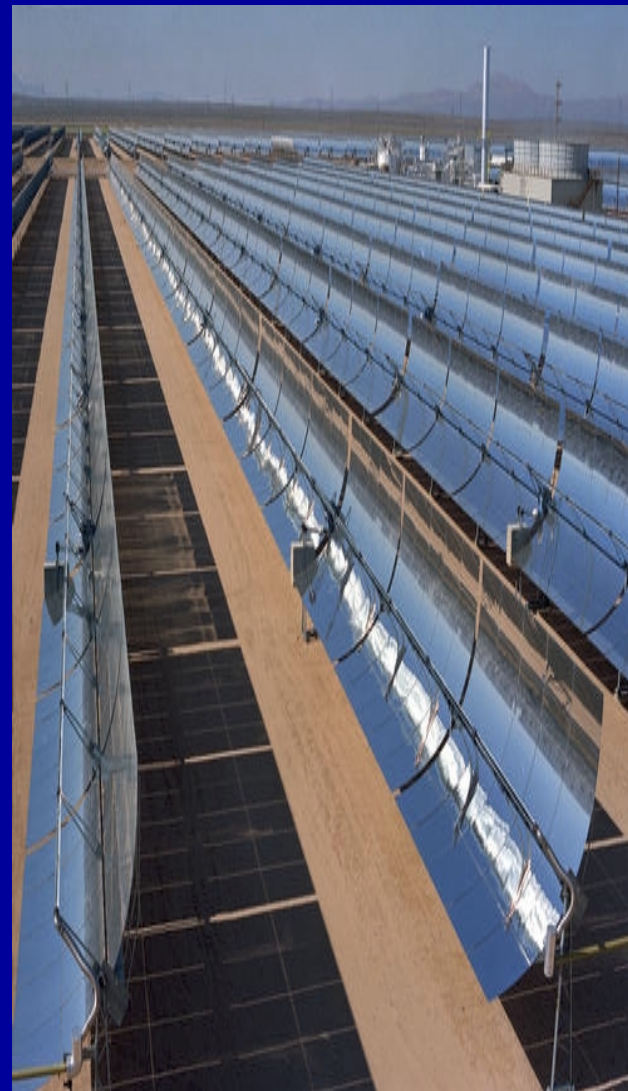
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Surface Solar Energy Project

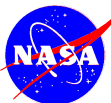
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Surface Energy Analysis & Forecasts

Date: 6/14/2002

Primary Partners:



Global long-term time series of industrial parameters; forecasted weather products for short-term (1-5 day), mid-term (10 day – 90 day) and long-term (1-2 year).

Global Temperature/Moisture information assimilated into forecast and analysis models (GIFTS); improved mid/long-forecasts

DSS improved with short/midterm forecasts; 1st long-term forecasts

Cloud Vertical Profile Statistics (CloudSat); Global aerosol distributions (Calipso)

DSS improved with parameter accuracy in time series & short-term forecasts; 1st mid-term forecasts.

Improved precipitation products (TRMM, AMSR, SSM/I); Analysis of global precipitation and energy fields; Forecasted parameters (NOAA)

DSS improved with addition of precipitation (biomass-fuel support); 1st short-term forecast of industrial parameters

Cloud, aerosol, energy data (Terra/Aqua) to improve/extend time series and evaluate/improve model forecasts; improved reanalysis (GSFC DAO)

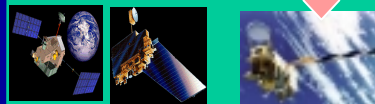
DSS improved due to increased accuracy of energy (solar and infrared) and meteorological (temp. humidity, winds, clouds) parameters

Increased resolution and extended time series (SRB and SSE)

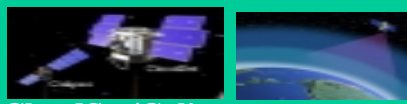
DSS improved with 1st 12-year time series data set of industrial parameters with worldwide coverage at 1° x 1° resolution

Surface site climatological mean input data, coarse resolution global data; little weather forecast data

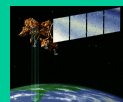
Incremental improvement in weather and climate forecasts from 1-2 day to 1-2 year predictions.



TRMM Terra Aqua



CloudSat/Calipso GIFTS



LDCM



NPOESS

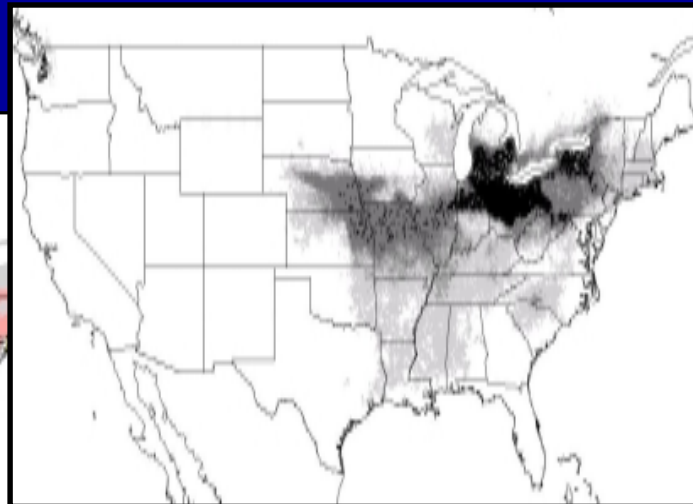
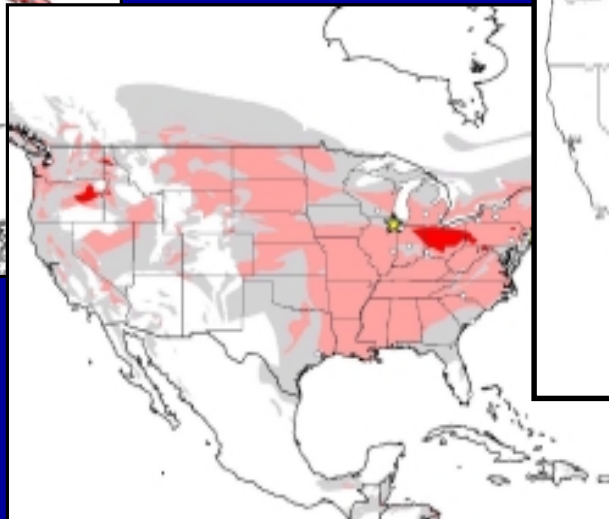
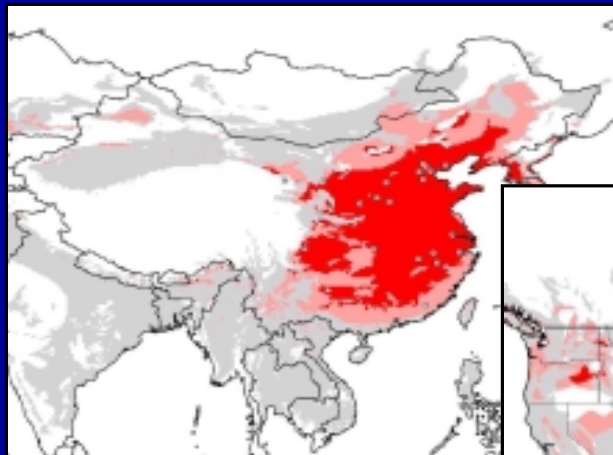
By 2012: Optimization of systems for the development of:

- renewable energy systems (including integration into power grid),
- energy-efficient buildings (construction, renovation, operations),
- biomass crop selection and maintenance strategies, and
- electric power load and supply assessments


Socioeconomic Impact

2000 2002 2004 2006 2008 2010 2012

- Infestations discovered in Asian import warehouses
- Models of climate and habitat control in Asia
- Model climate-based potential North American spread
- Forecast narrowed based on potential habitat



Invasive Species: Forecasting and Management of Invasive Species

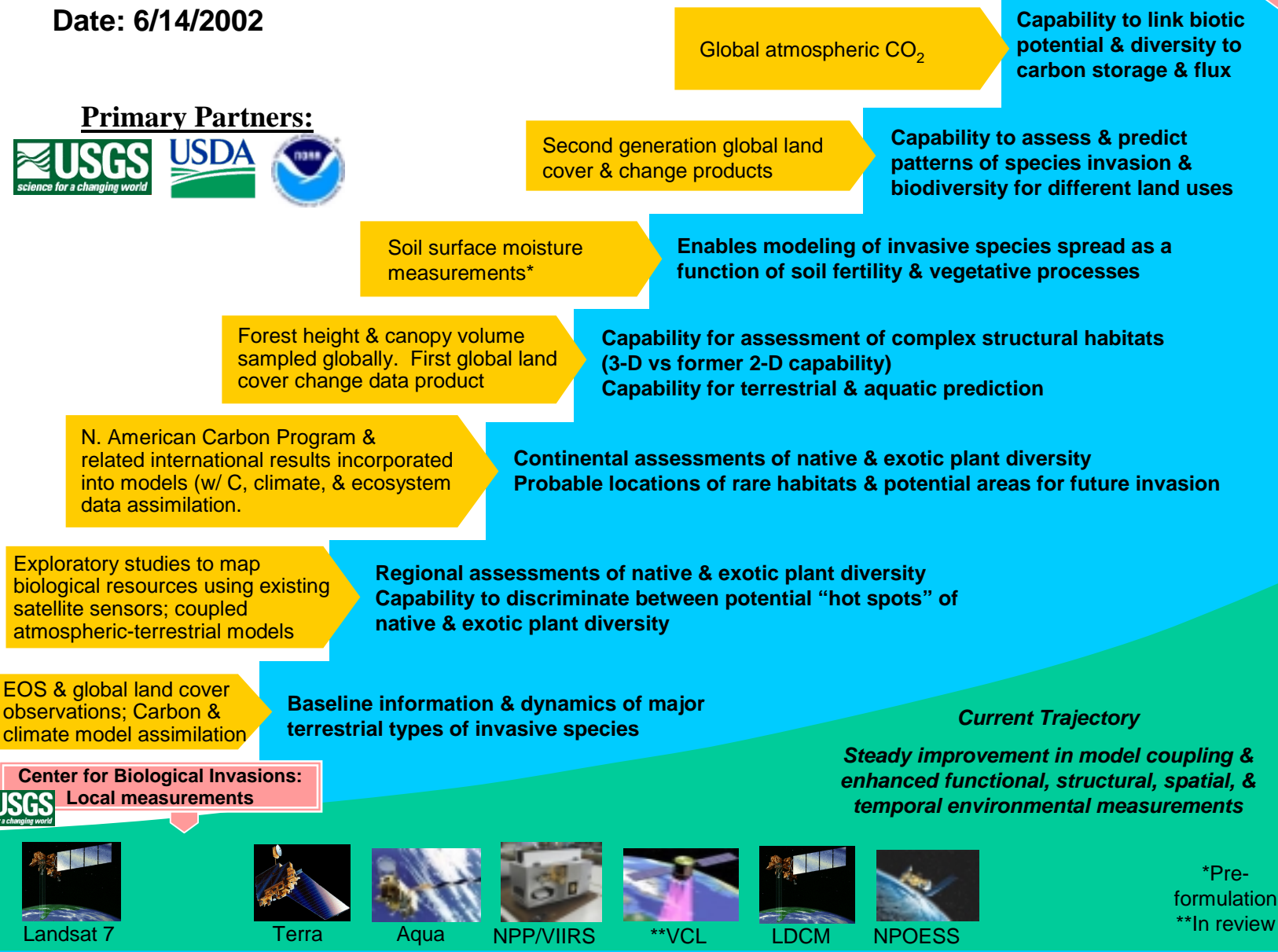
 **Center for Biological Invasions:**
Regional, National, Inter'l
measurements & predictions

Date: 6/14/2002

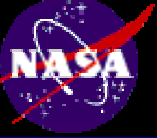
Primary Partners:



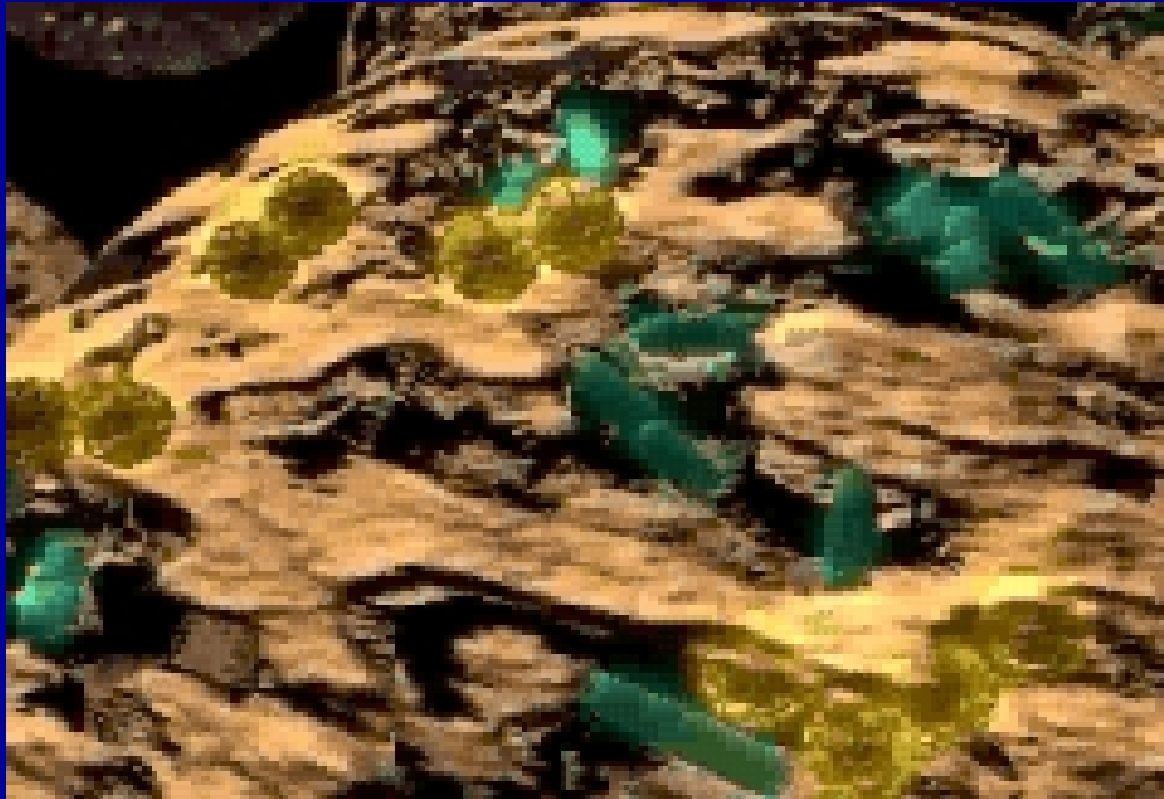
Socioeconomic Impact



An operational National Invasive Species Forecasting System for early detection & monitoring of biological invasions.



Public Health: Intercontinental Transport



Visualization depicting transport of microbes attached to dust particles by transoceanic winds from Africa to North America.

